some light and includes electrodes that are semi-transparent, partially reflective, or partially absorptive. In an alternative embodiment of the present invention, bottom electrode **16** may also be transparent, so that light may be emitted from both sides of the device. In such alternative embodiment, a second transparent low-index element may be employed between the scattering layer and the substrate, e.g. adjacent to the substrate.

[0037] According to the present invention, the transparent low-index element **18** may be located anywhere in the OLED device between scattering layer **22** and the encapsulating cover **20** (for a top-emitter) or between scattering layer **22** and the substrate **20** (for a bottom-emitter). Hence, in various embodiments the scattering layer **22** may be adjacent to either electrode **12** or **16** opposite the organic layers **14** as illustrated in **FIG. 1** for a top-emitter and in **FIG. 5** for a bottom emitter, or between the electrodes **12** and **16** and on either side of the organic layers **14** for a top-emitter, as illustrated in **FIGS. 2 and 3**. In yet another embodiment, the reflective electrode **16** may comprise multiple layers, for example a transparent, electrically conductive layer **13** and a reflective layer **15**. As shown in **FIG. 4**, the scattering layer may be located between the reflective layer **15** and the transparent, electrically conductive layer **13**. The reflective layer **15** may also be conductive, as may the scattering layer **22**. In this case, it is preferred that the transparent, conducting layer **13** have a refractive index in the first refractive index range.

[0038] Referring to **FIG. 5**, in another embodiment of the present invention, the organic light-emitting diode (OLED) device is constructed as a bottom-emitting device comprising a substrate **10**; an OLED having a first transparent electrode **12** formed over the substrate **10**, one or more layers **14** of organic light-emitting material formed over the first transparent electrode **12**, and a reflective second electrode **16** formed over the layer(s) **14** of organic light-emitting material to define a light-emitting area; the first transparent electrode **12** and layer(s) **14** of organic light-emitting material having a first refractive index range; a scattering layer **22** located over the substrate **10**. The substrate **10** has a second refractive index. Transparent low-index element **18** located between the scattering layer **22** and the substrate **10** has a third refractive index lower than the first refractive index range and the second refractive index. The configurations of **FIGS. 1, 2, 3**, and **4** may also be employed in a bottom-emitter configuration by locating the scattering layer **22** in the corresponding positions with the transparent low-index element **18** located as illustrated in **FIG. 5**. In these cases, the transparent low-index element **18** reduces the propagation of scattered light in the substrate **10** and reduces the loss of image sharpness as a result of this propagation.

[0039] In preferred embodiments, the encapsulating cover **20** and substrate **10** may comprise glass or plastic with typical refractive indices of between 1.4 and 1.6. The transparent low-index element **18** may comprise a solid layer of optically transparent material, a void, or a gap. Voids or gaps may be a vacuum or filled with an optically transparent gas or liquid material. For example air, nitrogen, helium, or argon all have a refractive index of between 1.0 and 1.1 and may be employed. Lower index solids which may be employed include fluorocarbon or MgF, each having indices less than 1.4. Any gas employed is preferably inert. Reflective electrode **16** is preferably made of metal (for example aluminum, silver, or magnesium) or metal alloys. Transparent electrode **12** is preferably made of transparent conductive materials, for example indium tin oxide (ITO) or other metal oxides. The organic material layers **14** may comprise organic materials known in the art, for example, hole-injection, hole-transport, light-emitting, electron-injection, and/or electron-transport layers. Such organic material layers are well known in the OLED art. The organic material layers typically have a refractive index of between 1.6 and 1.9, while indium tin oxide has a refractive index of approximately 1.8-2.1. Hence, the various layers **12** and **14** in the OLED have a refractive index range of 1.6 to 2.1. Of course, the refractive indices of various materials may be dependent on the wavelength of light passing through them, so the refractive index values cited here for these materials are only approximate. In any case, the transparent low-index element **18** preferably has a refractive index at least 0.1 lower than that of each of the first refractive index range and the second refractive index at the desired wavelength for the OLED emitter.

[0040] Scattering layer **22** may comprise a volume scattering layer or a surface scattering layer. In certain embodiments, e.g., scattering layer **22** may comprise materials having at least two different refractive indices. The scattering layer **22** may comprise, e.g., a matrix of lower refractive index and scattering elements have a higher refractive index. Alternatively, the matrix may have a higher refractive index and the scattering elements may have a lower refractive index. For example, the matrix may comprise silicon dioxide or cross-linked resin having indices of approximately **1.5**, or silicon nitride with a much higher index of refraction. If scattering layer **22** has a thickness greater than one-tenth part of the wavelength of the emitted light, then it is desirable for the index of refraction of at least one material in the scattering layer **22** to be approximately equal to or greater than the first refractive index range. This is to insure that all of the light trapped in the organic layers **14** and transparent electrode **12** can experience the direction altering effects of scattering layer **22**. If scattering layer **22** has a thickness less than one-tenth part of the wavelength of the emitted light, then the materials in the scattering layer need not have such a preference for their refractive indices.

[0041] In an alternative embodiment shown in **FIG. 6**, scattering layer **22** may comprise particles **23** deposited on another layer, e.g., particles of titanium dioxide may be coated over transparent electrode **12** to scatter light. Preferably, such particles are at least 100 nm in diameter to optimize the scattering of visible light. In a further top-emitter alternative shown in **FIG. 7**, scattering layer **22** may comprise a rough, diffusely reflecting surface **25** of electrode **16** itself or in a bottom-emitter alternative shown in **FIG. 8** scattering layer **22** may comprise a rough, diffusely refracting surface **27** of transparent electrode **12** itself. In an alternative bottom-emitter configuration, the scattering layer may be a rough, diffusely reflecting surface of the reflecting electrode **16**, or a rough, diffusely refracting surface of the transparent electrode **12**, of **FIG. 5**.

[0042] The scattering layer **22** is typically adjacent to and in contact with, or close to, an electrode to defeat total internal reflection in the organic layers **14** and transparent electrode **12**. However, if the scattering layer **22** is between the electrodes **12** and **16**, it may not be necessary for the